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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): H. Honbo, et al.
Application No. 09/897,613
Filed: July 3, 2001
For: NON-AQUEOUS SECONDARY BATTERY HAVING NEGATIVE
ELECTRODE INCLUDING GRAPHITE POWDER
Group: 1745
Examiner: J. S. Maples

**REQUEST FOR RECONSIDERATION
AFTER FINAL REJECTION**

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

July 26, 2004

Sir:

In response to the Office Action mailed April 21, 2004, Applicants respectfully submit the following remarks for establishing that the teachings of the applied reference, U.S. Patent No. 5,340,670 to Takami, et al., would have neither disclosed nor would have suggested the presently claimed subject matter.

As will be shown in the following, it is respectfully submitted that this reference does not disclose, nor would have suggested, an electrode for a non-aqueous secondary battery, or a non-aqueous secondary battery including, inter alia, a negative electrode, wherein the (negative) electrode includes graphite powder having a rhombohedral crystal structure in a range of 0-20% by weight and a particle size equal to or smaller than 100 μ m, and/or a hexagonal crystal structure in a range of at least 80% by weight and a particle size equal to or smaller than 100 μ m.

Furthermore, it is respectfully submitted that this reference would have neither disclosed nor would have suggested such a non-aqueous secondary battery, having the recited maximum amount of 20% by weight of rhombohedral crystal structure in addition to the recited particle size, wherein the graphite powder includes at least a fraction having hexagonal crystal structure. See claims 32 and 33.

The present invention is directed to a non-aqueous secondary battery using a negative electrode made of graphite powder, as well as to such negative electrode of graphite powder. The present invention has use, for example, in connection with a lithium battery, and provides such battery which can have an high energy density and a long life, and which has excellent intercalation capacity (that is, an increased capacity of the battery).

Carbon material has been proposed as the negative electrode active material, in place of lithium metal, in lithium batteries, in which charge and discharge reactions involving lithium ion intercalation into the carbon material and deintercalation from the carbon material occur. However, in previously proposed batteries (e.g., lithium batteries) using carbon material as active material for the negative electrode, a large capacity cannot be obtained; and, moreover, preferable performances of rapid charging and discharging are not obtained. Note the paragraph bridging pages 2 and 3 of Applicants' specification.

Against this background, Applicants provide a negative electrode using carbon powder as active material, which active material has good charging and discharging characteristics, while having a large capacity (large intercalation capacity). Applicants have found that by using graphite powder having hexagonal crystal structure, for the overall structure (which, e.g., has laminated graphite layers);

and, in particular, by limiting the amount of rhombohedral crystal structure of the graphite powder, and increasing the amount of graphite powder having hexagonal crystal structure, various advantages are achieved. In particular, by reducing the graphite powder having rhombohedral crystal structure and using graphite powder having hexagonal crystal structure, intercalation capacity of the negative electrode is increased. That is, the number of storage sites for lithium anodes in the negative electrode is increased.

According to the present invention, the hexagonal crystal structure of the whole graphite is increased, to have the specified minimum hexagonal crystal structure, due to an orderliness and regularity of the lamination of the hexagonal-net-plane layers. It is respectfully submitted that the fundamental hexagonal crystal structure according to the present invention is achieved based upon regularity and orderliness of the lamination, and based thereon differs from the rhombohedral crystal structure. In accordance with the present invention, the existing ratio of hexagonal crystal structure for the graphite as a whole is specified at a high level, in order to achieve the increased capacity of the battery as described in Applicants' disclosure.

In comparison, and as will be discussed further infra, Takami, et al. discloses hexagonal-net-plane layers, which are laminated; however, this reference is silent with respect to orderliness and regularity of the laminated hexagonal-net-plane layers. It is respectfully submitted that this reference would not have disclosed, nor would have suggested, providing hexagonal crystal structure of the graphite powder, which increases capacity of the battery, only discloses that lithium ions can be intercalated between the hexagonal-net-plane layers. In fact, as discussed further

infra, by disclosing "appropriate displacements, twists, and angles" of the planar layers to one another (note, e.g., column 7, lines 29-40, of Takami, et al.), Takami, et al. would have taught away from the presently claimed invention including hexagonal crystal structure of the graphite powder.

To emphasize, in accordance with the present invention, graphite is used as material for the negative electrode, and a focus thereof is on crystallinity of the entire material (not only of layers which form the lamination). That is, Applicants have found that by using graphite powder having hexagonal crystal structure (having regularity and orderliness between laminated layers), and, in particular, by using graphite powder having a specific ratio of hexagonal crystal to rhombohedral crystal, of the crystal structure as a whole, of the graphite powder, improvements in capacity are achieved. Using hexagonal crystal structure, and, in particular, at least a minimum amount of hexagonal crystal structure relative to rhombohedral crystal structure, unexpectedly better results of improved capacity are achieved, for the electrode and battery of the present invention.

It is emphasized that Applicants limit the amount of rhombohedral structure, according to an aspect of the present invention; and, moreover, according to aspects of the present invention, Applicants use graphite powder having hexagonal crystal structure of the graphite powder as a whole, with orderliness and regularity between the laminate layers of the graphite, so as to achieve advantages of increased capacity according to the present invention.

Takami, et al. discloses a negative electrode carbonaceous material suitable for a lithium secondary battery, as well as a battery for using this negative electrode carbonaceous material. According to Takami, et al., the negative electrode contains

a carbonaceous material which has an exothermic peak at 700°C or more when measured by a differential thermal analysis; an intensity ratio P_{101}/P_{100} of a (101) diffraction peak P_{101} to a (100) diffraction peak P_{100} of a graphite structure, obtained by X-ray diffraction analysis, of 0.7 to 2.2; and absorbs and desorbs lithium ions. See column 3, lines 1-8. Other negative electrodes disclosed in Takami, et al., as part of the described invention therein, are described at column 3, lines 16-25, 38-44, and 56-60 and 66-68; as well as in column 4, lines 9-13, 17 and 18.

Note also column 20, lines 25-56; column 21, lines 3-22; column 22, lines 1-19 and 37-62; and column 23, lines 10-21, for other disclosures in connection with negative electrodes of the secondary battery of Takami, et al. These disclosures all refer to the carbonaceous material having a graphite structure that exhibits a property of allowing easy reversible absorption and desorption of lithium ions to and from between hexagonal-net-plane layers in the graphite structure. Note also, for example, Example 1 in column 24, and particularly lines 23-29 thereof, disclosing that the carbonaceous material used was a graphitized carbon powder with an average particle size of 25 μm , which was distributed at a ratio of 90 vol % within the range of 1-50 μm in a particle size distribution, and in which the ratio of particles with a particle size of 0.5 μm or less was 0 vol % in the particle size distribution. Note also, inter alia, Example 2 and the description in connection therewith at column 25, lines 20-26; and Example 3 and the discussion in connection therewith at column 25, lines 53-59, describing particle size of the carbonaceous material.

It is respectfully submitted that Takami, et al. discloses structure having hexagonal-net-plane layers. It is respectfully submitted that this disclosure would have neither taught nor would have suggested the hexagonal crystal structure of the

graphite powder as a whole, which has a laminate of planar layers, or the recited amount (especially maximum amount) of rhombohedral crystal structure as in the present claims, much less amount of hexagonal crystal structure of the graphite powder as a whole, as in the present claims.

The contention by the Examiner that the language in column 14, lines 30-43, of Takami, et al. (that the carbonaceous material is of a crystallite structure in a hexagonal-net-plane layer) meets Applicants' claimed subject matter of an anode hexagonal crystal structure, is respectfully traversed. It is respectfully submitted that the claims refer to the crystal structure of the graphite powder as a whole, not to individual layers of the laminate thereof (i.e., without the lamination). Properly construing the language of the present claims, it is respectfully submitted that Takami, et al. would have neither disclosed nor would have suggested the powder having the recited crystal structure and recited particle size, and advantages thereof as discussed previously.

The additional contention by the Examiner that he consulted an expert examiner in the carbon field "within the Patent [and Trademark] Office and he stated that Takami discloses hexagonal crystal structure for the anode" is noted. Applicants do not traverse any contention by the Examiner that Takami, et al. discloses each of the layers of the laminate, per se (outside the laminated structure) have hexagonal-net-plane layers; however, in the lamination, it is respectfully submitted that Takami, et al. does not disclose, nor would have suggested, the hexagonal crystal structure achieved, e.g., by orderliness and regularity of the lamination, achieving the crystal structure of the material as a whole as in the present claims. In this regard, it is respectfully submitted that if the Examiner is relying on testimony of the "expert

examiner in the carbon field”, that the graphite powder structure as a whole of Takami, et al. has hexagonal crystal structure and small amount of rhombohedral structure as in the present claims, the Examiner must provide an affidavit from the “expert examiner in the carbon field” stating his reasons that Takami, et al. discloses hexagonal crystal structure for the graphite powder as a whole, as compared with a disclosure of hexagonal-net-plane structure.

The contention by the Examiner in the second full paragraph on page 3 of the Office Action mailed April 21, 2004, in connection with high crystallinity and minimum twisted structures, is noted. To properly characterize Applicants’ arguments, it is noted that Takami, et al., in column 7, lines 29-40, recites that a carbonaceous material having an intensity ratio P_{101}/P_{100} within the recited range has a graphite structure developed to a proper degree, and hexagonal-net-plane layers stacked in this graphite structure have appropriate displacements, twists and angles to one another; and that when the stacked hexagonal-net- plane layers have appropriate displacements, twists and angles to one another, lithium ions diffuse more easily between the hexagonal-net-plane layers, so the carbonaceous material presents a property of reversibly, rapidly absorbing and desorbing a large number of lithium ions. Such disclosure of a carbonaceous material having “appropriate displacements, twists and angles to one another”, as described in column 7 of the applied reference, would have neither disclosed nor would have suggested the crystal structure according to the present invention, having the recited hexagonal crystal structure as a whole, achieved, for example, by the orderliness and regularity of lamination of the laminated layers of the graphite, and advantages thereof as discussed previously.

To emphasize, it is respectfully submitted that such “displacements, twists and angles” in Takami, et al. are contrary to the orderly and regular lamination as in the present invention. Based on the difference in regularity of the laminated structure, the hexagonal crystal structure of the present invention differs from the rhombohedral structure. Noting that Takami, et al. provides no disclosure as to regularity and orderliness of the laminated hexagonal-in-plane layers, and in fact requires appropriate displacements, twists and angles, this reference would not have taught or suggested the presently claimed invention, including amount of hexagonal crystal structure and/or rhombohedral crystal structure of the graphite powder. To be specific, disclosure of graphite having hexagonal-net-plane structure, without more, would have neither taught nor would have suggested the graphite powder with amount of hexagonal crystal structure and/or amount of rhombohedral crystal structure as in the present claims, especially in light of the disclosure of appropriate displacements, twists and angles as in Takami, et al.

The contention by the Examiner in the last paragraph on page 3 of the Office Action mailed April 21, 2004, is noted. Contrary to the conclusion by the Examiner, it is respectfully submitted that Takami, et al., does not set forth “the same carbon crystal material”, as a whole, as in the present claims; and, accordingly, the contention by the Examiner that it is inherent that the material of Takami, et al. would have the same capacity as Applicants have claimed is erroneous.

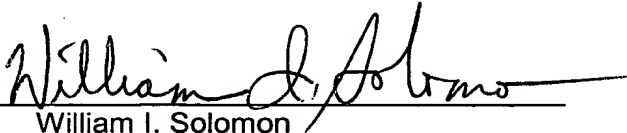
In view of the foregoing comments, reconsideration and allowance of all claims remaining in the application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of

this paper, including extension of time fees, to the Antonelli, Terry, Stout & Kraus, LLP Deposit Account No. 01-2135 (Docket No. 503.34465VV4), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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